Ancilliary Devices

By Cherub Log and “Skip” Distance

In keeping with the focus of the articles in this issue of the NHS Journal, what follows here is a brief introduction to those electronic devices which were developed and used in conjunction with Radar. These were:

1. IFF. Identification Friend and Foe
2. DF. Direction Finding, MF, HF and VHF
3. Loran. Long Range Radio Navigation.
4. Radio Beacon
5. Radio Altimeter
6. Radio Compass
7. Typex encryption machine
8. Sonobuoy

1. IFF. Identification Friend and Foe.

This system was developed as ship borne and airborne equipment. Both operated on the same principle which was an automatic signal being transmitted from an interrogator to a target (ship or aircraft). If the target was fitted with a corresponding transponder, an automatic signal would be sent back to the receiver unit of the transmitting interrogator, and displayed on the Radar screen. In this case the target would be deemed “Friend”. Should there be no response from the target for any one of a number of possible causes, it would be deemed “Foe”. Security was provided by coding which could be manually incorporated into the units of the system. Thus if the enemy had access to the system units, he would also have to know the code settings for the day or time of operation in order to make effective use of the equipment.

The operational sequence for a ‘Friend’ was firstly a signal would be transmitted by the Interrogator’s transmitter. This would be received in the receiver unit of the Friendly Transponder which in turn would respond automatically by transmitting a response. The rersponse would be received by the Interrogator’s receiver unit, called a Responsor, and a coded signal would be displayed on the associated Radar’s PPI or other display unit.

The ship borne interrogators were 242, 243, 941, 944. The shipborne transponders were 253, 954. The airborne AN-APX1, carried by all R.A.N. aircraft was a transponder only. The AN-APX 2, carried by Fireflies Mks 5 & 6 only, was an interrogator and transponder. (See separate article by Ch RE Gordon Wood)

2. DF. Direction Finding.

This was a device developed to provide an aircraft with information about its bearing relative to its operations base, whether this was a ground station or aircraft carrier. Normal HF or VHF transmissions from the aircraft would be received by the base receiver, such as AH6 or FH4 for HF and FV5 for VHF, and the relative bearing of the aircraft to the base would be automatically displayed on a PPI screen. This information could then be relayed to the aircraft via the usual HF or VHF communication channel. There was also a little used MF version, the FM12.

3. LORAN. Long Range Radio Navigation.

This is a device developed to aid in ship navigation over long distances. Typically 3 transmitting stations in a group would operate on the same frequency. All transmitting stations would be fixed and of known latitude and longitude. One station in the group would be the Master and the others the Secondaries. The principle of operation was to create pulsed signals at precise time intervals, such that a receiver tuned to the group frequency could compute the time differential between the Master and the Secondary signals, and from this derive a rough fix on the latitude and longitude of the receiving ship or aircraft. To provide world wide coverage, the fixed base Loran transmitters were high power and operated in the HF range at around 100 MHz.

LORAN could cover a vast geograhical area, but its definition for close navigation was unsatisfactory. To address this need of a reliable navigational aid in confined waters where shipping traffic was heavy, such as the English Channel, the “Decca Navigator” was introduced. Unlike LORAN, the principle of this system was that it used continuous transmission, and the phase differences of received signals from a number of relatively close shore based fixed sites were measured to establish the position of the receiving vessel. In the 21st century, Loran is still used extensively, in particular in the European community, as it is regarded as a safe alternative to other global positioning systems.

4. Radio Beacon.

This device was a VHF transmitter with a slowly rotating directional aerial. Within every twenty four 15 degree sectors of the compass, the transmitter would transmit a morse code symbol twice. For example, in the sector north through 15 degrees east the morse signal might be A (dit dah). Then in the next sector North 15 degrees east through N 30 degrees east the signal might be O (dah dah dah). And so on with a different morse signal for all of the 24 compass sectors. Upon receiving these audio signals, the aircraft crew would know in which general direction lay their base. The transmitters were YG beacon for land based and YE beacon for ship based transmiters. The aircraft installation was ZBX.

The advent of GPS has improved considerably the navigational assistance available to ships and aircraft.

5. Radio Altimeter (AYF)

This radio device operated on a principle different from that of Radar. The Radar principle is that the frequency of the signal is fixed and a comparison is made of the time of the transmitted signal with the different time of the returned signal. (See discussion on doppler Effect in the article Radar Basics). In the radio altimeter, the transmission is frequency modulated, ie continually changing at a predetermined frequency. It is the frequency of the transmitted signal which is compared with the different frequency of the returned signal that is used to compute the aircraft’s altitude. Note that this system is quite independent of atmospheric pressure which is the basis for regular altimeter construction. The transmitted frequency was frequency modulated at 120 cycles per second. At the higher range of 4,000 feet altitude, the operating frequency was 442 to 446 Mcs, and at the lower altitude range the operating frequency was 420 to 460 Mcs

6. The Typex Encryption Machine.

The Germans invented the “Enigma” machine in 1926. It wasn’t until 1936 that the British decided to have their own machine cryptograph for enciphering all radio traffic. The Typex was based on the Enigma, but the early versions were quite inferior in design and operation when compaed with Enigma. This was evident when the British troops were forced to evacuate Dunkirk, a number of Typex machines were left on the beach. Discovered by the Germans, the machines were simply destroyed as the Germans knew the Typex limitations. Various improved models were progressively developed, but it wasn’t until the Mark VIII Typex was released that the British had a machine capable of receiving and transmitting morse code signals and automatically causing plain text to be printed.

The Typex was an electromechanical device, with no electronic circuitry, simply direct current. It was essentially a standard typewriter keyboard connected to a teletype machine, but with infinitely variable internal electrical connections via a series of notched circular rotors. Each rotor had 26 double electrical contacts on both ends. Each contact on one end of a rotor was hard wired to a contact at the other end, but each rotor was wired differently from all others. Typically 25 rotors, each identified by a unique number, were supplied with a Typex device, and typically 5 rotors would be fitted to the machine. One rotor was static and the others rotated. Each day, the rotor sequence would be changed, not by moving the rotors but by a plug board, similar to the very early manually operated telephone exchanges. Every Typex had to be changed identically and co-incidentally for the whole communication system to operate

correctly. Thus via the transmitting and receiving Typex machines, encrypted electronic messages could be securely exchanged. Typex machines remained in use until the early 1970s.

7. Sonobuoy.

Early sonobuoys were non directional. Each cylindrical cannister which contained the detecting and transmitting equipment was about 80 centimetres long and 12 centimetres in diameter. At the base of the cylinder was a hydrophone connected to the transmitter via an electrical cable 10 metres long. At the top of the cylinder was a whip aerial attached to the cylinder by a coil spring, and restrained against the cylinder by a quick release clip. Upon being dropped by the aircraft, impact with the water surface would cause three actions to occur. One would be to release the hydrophone which would descend in the water until stopped by the connecting cable. Secondly the aerial quick release clip would disengage, allowing the aerial to spring up and assume a vertical orientation. Thirdly the battery power to the amplifier and transmitter would be switched on, and the device would be in immediate operational mode. Operational frequency range was 62.9 to 71.7 Mcs. Effective range was a maximum of 3 miles. Battery duration was 4 hours.

Non directional sonobuoys were generally tuned to one of 6 different frequencies. As a pattern of sonobuoys was dropped, the observer would note the relative position of each one, such that when a target created audio noise was picked up by the hydrophones, the observer would know the approximate position of the target by tuning his receiver to the preset transmitter frequencies.

Later versions of sonobuoy had directional hydrophones, which meant that as few as 2 would need to be dropped in a pattern in order to get a fix on a target.